

IEEE802.3at compliant PD + PS design based on PM8803 low power, synchronous flyback PoE converter

Introduction

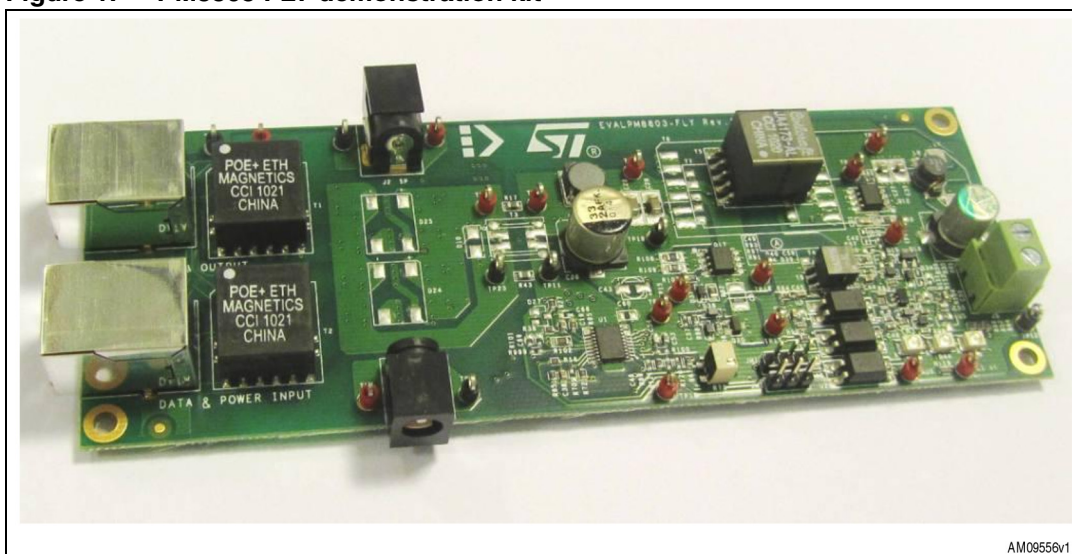
PM8803 is a highly integrated device embedding an IEEE802.3at compliant powered device (PD) interface together with a PWM controller and support for auxiliary sources.

[Figure 1](#) is an image of the PM8803 demonstration board. The same PCB can be populated with different components to support various configurations and topologies: synchronous flyback with or without active clamp, flyback with diode rectification, synchronous forward with or without active clamp, forward with diode rectification.

This document focuses on a reference design for a high efficiency, low power PD (up to 7 W) power converter based on flyback topology with synchronous rectification using the PM8803 as the main controller. This converter can be derived from a PM8803 demonstration board with a few component changes.

Schematics of the PoE converter are given in [Section 2](#) while the related bill of material is detailed in [Section 3](#). In [Section 4](#) efficiency measurements, together with the main waveforms of the PoE interface and the flyback converter, are shown.

Figure 1. PM8803 FLY demonstration kit



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1 Electrical specifications

Table 1. Specifications for 3.3 V output

Parameter	Description	Min.	Typ.	Max.	Unit
Input voltage range	Applied at J3 connector	0		57	V
Operative input voltage		42		57	V
UVLO	Vin rising edge			36	V
	Vin falling edge	30			V
Auxiliary input voltage range		35		60	V
Output voltage (Vout)	Vin = 42 V to 57 V, Iout 0 to I _{max}	3.25	3.35	3.45	V
Output current (Iout)	Vin = 42 V to 57 V	0		2	A
Peak-to-peak output ripple	48 Vin, Iout = I _{max}		50	70	mVpp
Inrush current limit			140		mA
DC current limit			440		mA
Efficiency DC-DC only	Vin = 48 V, Iout = I _{max}		90		%
Overall efficiency	Vin = 48 V, Iout = I _{max}		88		%
Switching frequency			250		kHz

2 Demonstration kit schematic

Figure 2. Demonstration kit schematic: detail of the input section including data transformers, diode bridges, protection, and optional CM choke

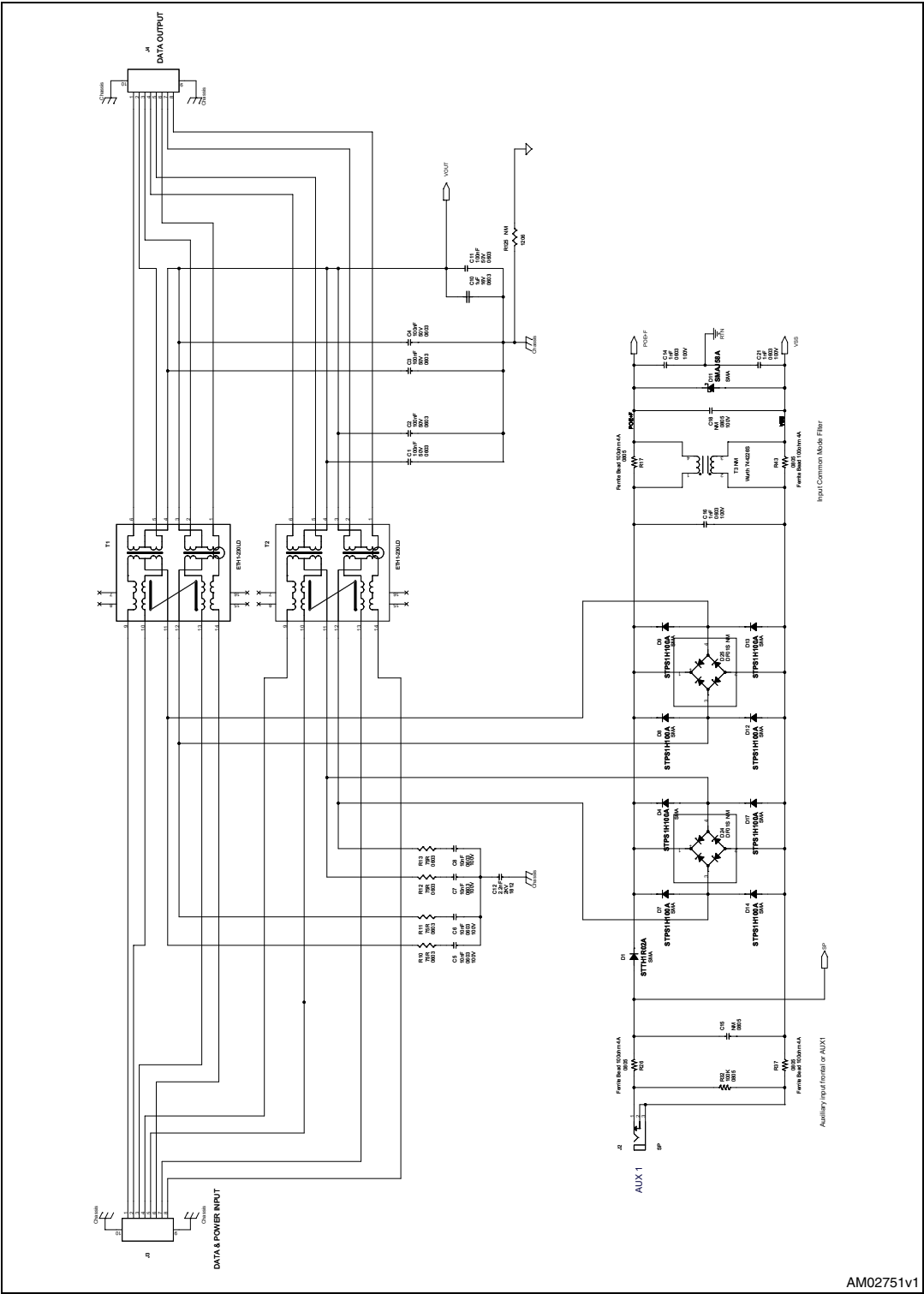
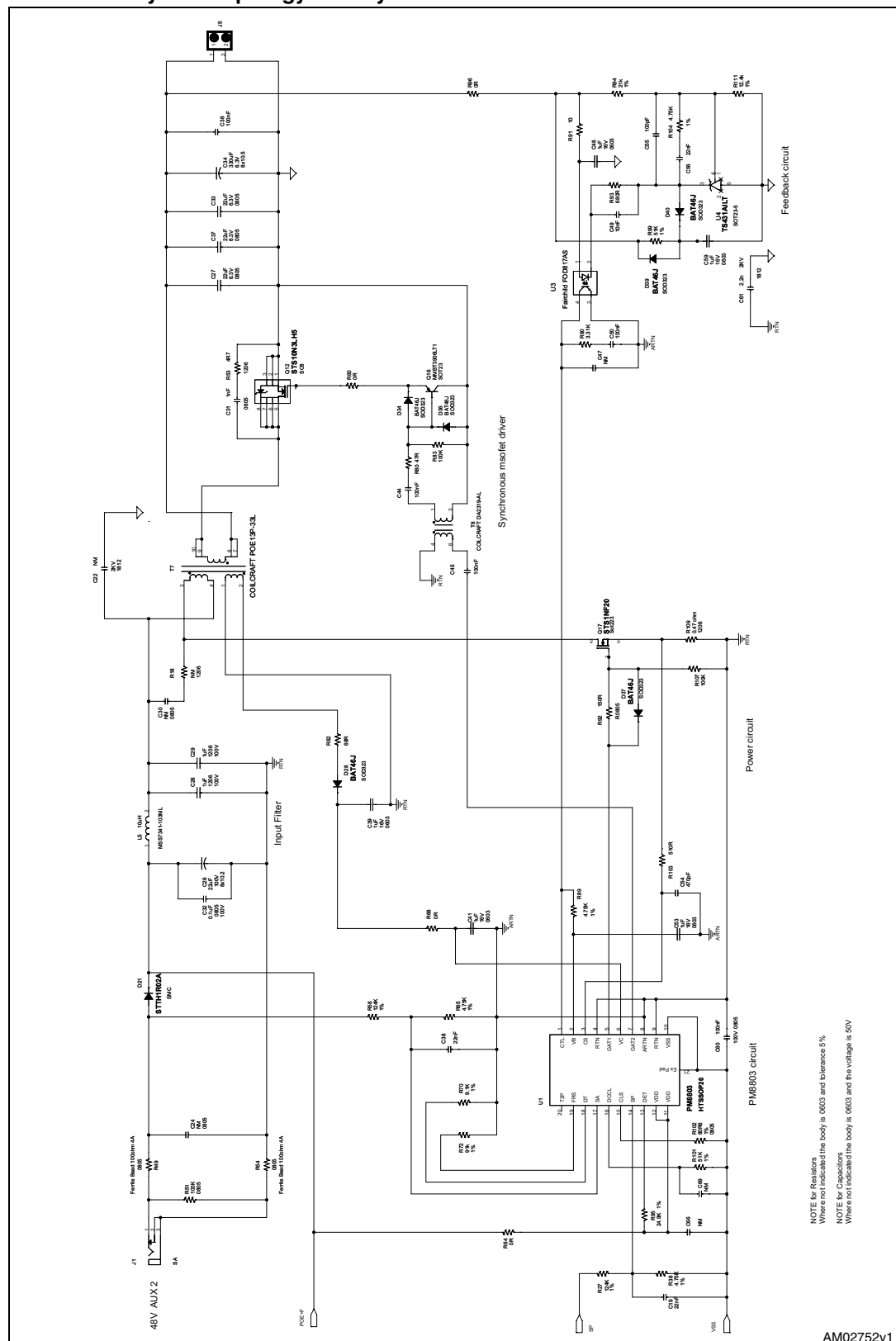


Figure 3. Demonstration kit schematic: detail of the PoE converter based on flyback topology with synchronous rectification



Bill of material

Table 2 shows the bill of material for the PoE converter based on the PM8803.

Table 2. Bill of material

Qty.	Reference	Description	Value	Tol.	Voltage	Body	Vendor
1	EVALPM8803 FLY rev1	Board PCB					
8	C1,C2,C3,C4,C11C36,C44,C45	Ceramic capacitor	100 nF		50 V	603	Std
4	C5,C6,C7,C8	Ceramic capacitor	10 nF	10%	100 V	603	TDK
6	C10,C39,C41,C48C53,C59	Ceramic capacitor	1 μ F	20%	16 V	603	Std
1	C12	Ceramic capacitor	2.2 nF		2 kV	1812	TDK
3	C14,C16,C21	Ceramic capacitor	1 nF	10%	100 V	603	TDK
NM	C15,C24,C30	Ceramic capacitor	NM			805	NM
2	C19,C38	Ceramic capacitor	22 nF		50 V	603	Std
NM	C22	Ceramic capacitor	NM			1812	NM
1	C26	Aluminium capacitor	22 μ F	20%	100 V	810x10.2	Std Low ESR
3	C27,C33,C37	Ceramic capacitor	22 μ F	20%	6.3 V	805	Std
2	C28,C29	Ceramic capacitor	1 μ F	20%	100 V	1206	TDK
1	C31	Ceramic capacitor	1 nF	10%	100 V	805	Std
2	C32,C60	Ceramic capacitor	0.1 μ F	10%	100 V	805	TDK
1	C34	Aluminium capacitor	330 μ F		6.3 V	8x10.2	Std Low ESR
NM	C40	Ceramic capacitor	NM			805	NM
NM	C43	Aluminium capacitor	NM			4x6	NM
NM	C47,C66,C69	Ceramic capacitor	NM			603	NM
1	C49	Ceramic capacitor	10 nF		50 V	603	Std
1	C50	Ceramic capacitor	100 nF		50 V	603	Std
1	C54	Ceramic capacitor	470 pF		50 V	603	Std

**Table 2. Bill of material (continued)**

Qty.	Reference	Description	Value	Tol.	Voltage	Body	Vendor
1	C55	Ceramic capacitor	100 pF		50 V	603	Std
1	C56	Ceramic capacitor	22 nF		50 V	603	Std
1	C61	Ceramic capacitor	2.2 nF		2 kV	1812	TDK
1	D1,D21	Std diode	STTH1R02A		200 V	SMC	ST
1	D32	Zener diode	BZX84C10			SOT23	Std
8	D4,D7,D8,D9,D12D13,D14, D17	Schottky diode	STPS1H100A		100 V	SMA	ST
1	D11	TVS diode	SMAJ58A			SMA	ST
1	D23	Schottky diode	STPS1H100A		100 V	SMA	ST
NM	D24,D25	Bridge rectifier	NM			SDIP	NM
6	D28,D34,D36,D37D39,D40	Schottky diode	BAT46J		100 V	SOD323	ST
2	J1,J2	Power jack	SA,SP				Std
1	J3	RJ45 connector	Data & power input				Std
1	J4	RJ45 connector	Data output				Std
1	J5	Terminal block 2-way	MOR-10X10.5-P5-2PIN				Std
1	L5	SMT inductor	10 μ H			MSS7341-103ML	Coilcraft
1	Q12	Mosfet N-channel	STS10N3LH5		30 V	SO8	ST
1	Q16	Transistor, PNP	MMBT3906LT1		40 V	SOT23	Std
1	Q17	Mosfet N-channel	STS1NF20		200 V	SOT223	ST
4	R10,R11,R12,R13	Chip resistor	75 Ω			603	Std
6	R17,R26,R37,R43 R49,R54	Ferrite bead	MPZ012101A		100R,4A	805	TDK
NM	R18	Chip resistor	NM			1206	NM
2	R27,R58	Chip resistor	124 k Ω	1%		603	Std
2	R32,R51	Chip resistor	100 k Ω			805	Std

**Table 2. Bill of material (continued)**

Qty.	Reference	Description	Value	Tol.	Voltage	Body	Vendor
4	R38,R65,R89, R104	Chip resistor	4.75 k Ω	1%		603	Std
1	R53	Chip resistor	4R7			1206	Std
3	R60,R64,R68	Chip resistor	0 Ω			603	Std
1	R62	Chip resistor	68 Ω			603	Std
1	R70	Chip resistor	9.1 k Ω	1%		603	Std
1	R72	Chip resistor	91 k Ω	1%		603	Std
1	R80	Chip resistor	47 Ω			603	Std
2	R83,R107	Chip resistor	100 k Ω			603	Std
1	R89	Chip resistor	2.7 k Ω			603	Std
1	R90	Chip resistor	3.31 k Ω	1%		603	Std
1	R91	Chip resistor	10 Ω			603	Std
1	R92	Chip resistor	150 Ω			603	Std
1	R93	Chip resistor	680 Ω			603	Std
1	R94	Chip resistor	21 k Ω	1%		603	Std
1	R95	Chip resistor	24.9 k Ω	1%		603	Std
1	R96	Chip resistor	0 Ω			603	Std
2	R99,R101	Chip resistor	51 k Ω	1%		603	Std
1	R102	Chip resistor	80R6	1%		805	Std
1	R103	Chip resistor	510 Ω			603	Std
1	R104	Chip resistor	3.31 k Ω	1%		603	Std
1	R109	Chip resistor	0.47 Ω	1%		1206	Std low value
1	R111	Chip resistor	12.4 k Ω	1%		603	Std
NM	R125	Chip resistor	NM			603	NM
2	T1,T2	POE+ Magnetics	ETH1-230LD				Coilcraft

**Table 2. Bill of material (continued)**

Qty.	Reference	Description	Value	Tol.	Voltage	Body	Vendor
NM	T3	CM choke	NM				NM
1	T7	Power transformer	POE13P-33L				Coilcraft
1	T8	Gate driver transformer	DA2319-AL				Coilcraft
1	U1	POE+ controller	PM8803			HTSSOP20	ST
1	U3	SMT optocoupler	Fairchild FOD817AS			4PDIP	Fairchild
1	U4	Shunt regulator	TS431AILT			SOT23-5	ST

4 Test results

4.1 Efficiency measurements with synchronous rectification

Figure 4. Efficiency measurements at 48 V input

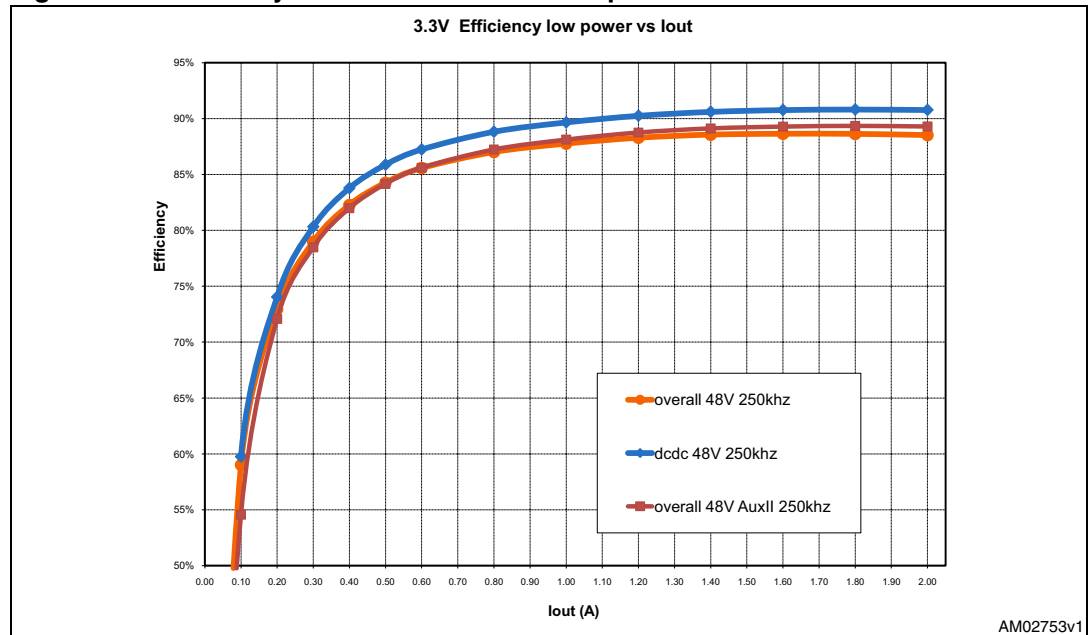
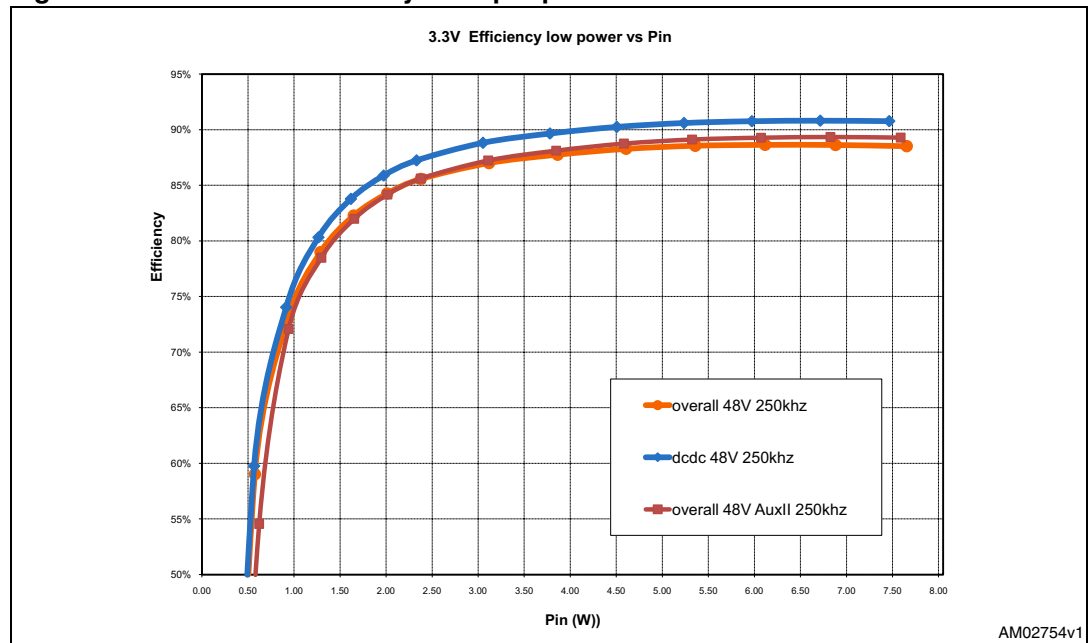


Figure 5. Converter efficiency vs. input power

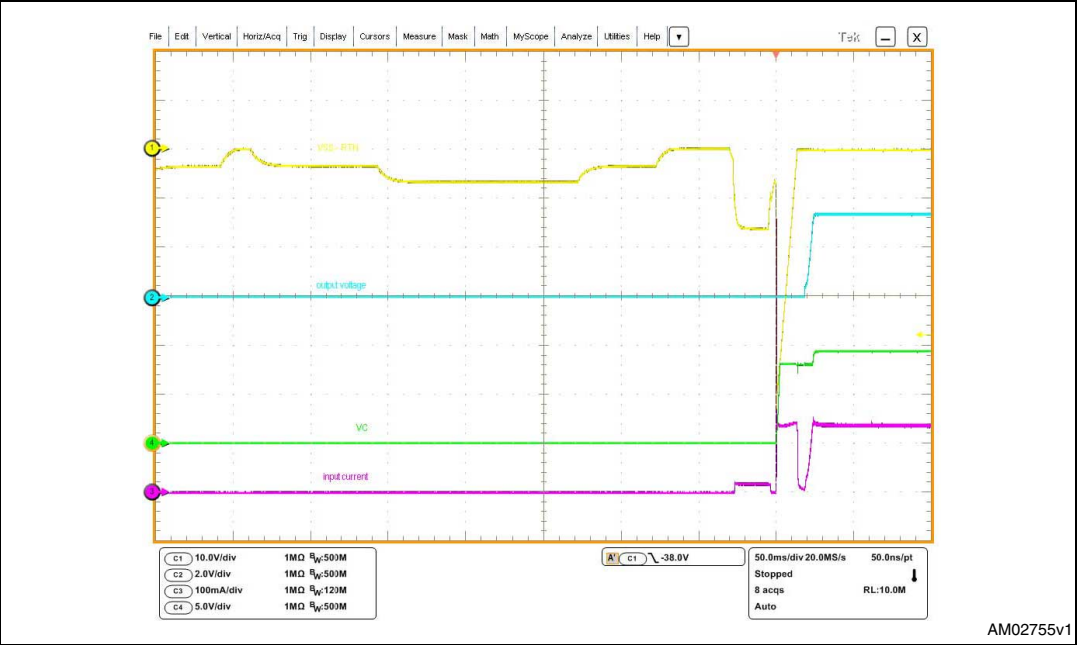


The difference between DC-DC and overall measurements is about 2% from 0.8 A to 2 A.

4.2 Converter waveforms

4.2.1 Startup sequence from PoE injectors

Figure 6. Startup from an IEEE 802.3af injector with 2 A load



4.2.2 Primary side MOSFET

Figure 7. Primary side power MOSFET waveforms at 0 A load

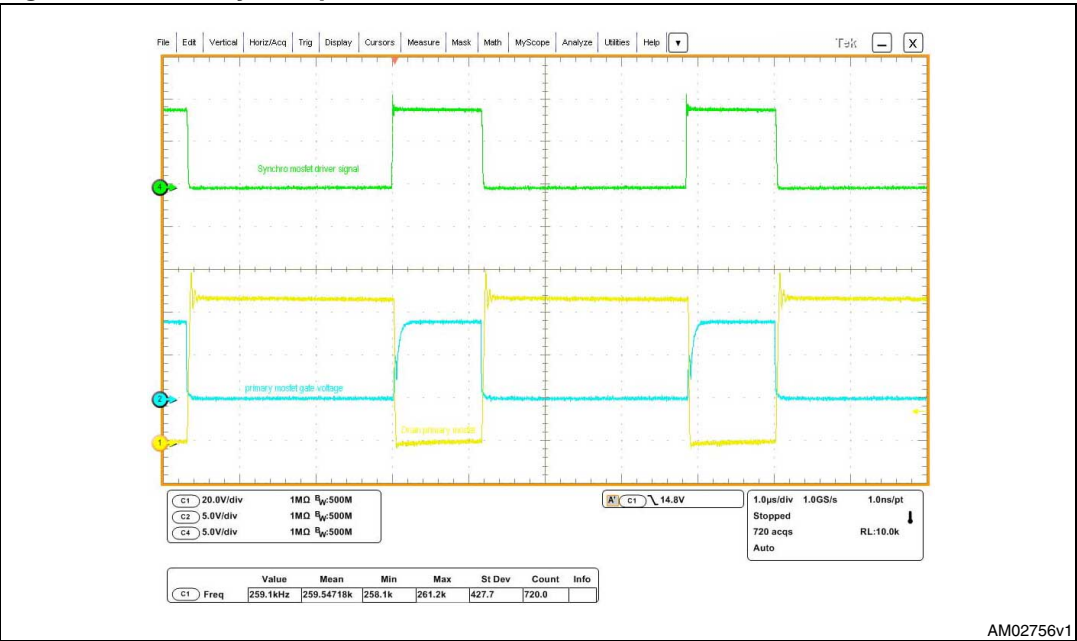
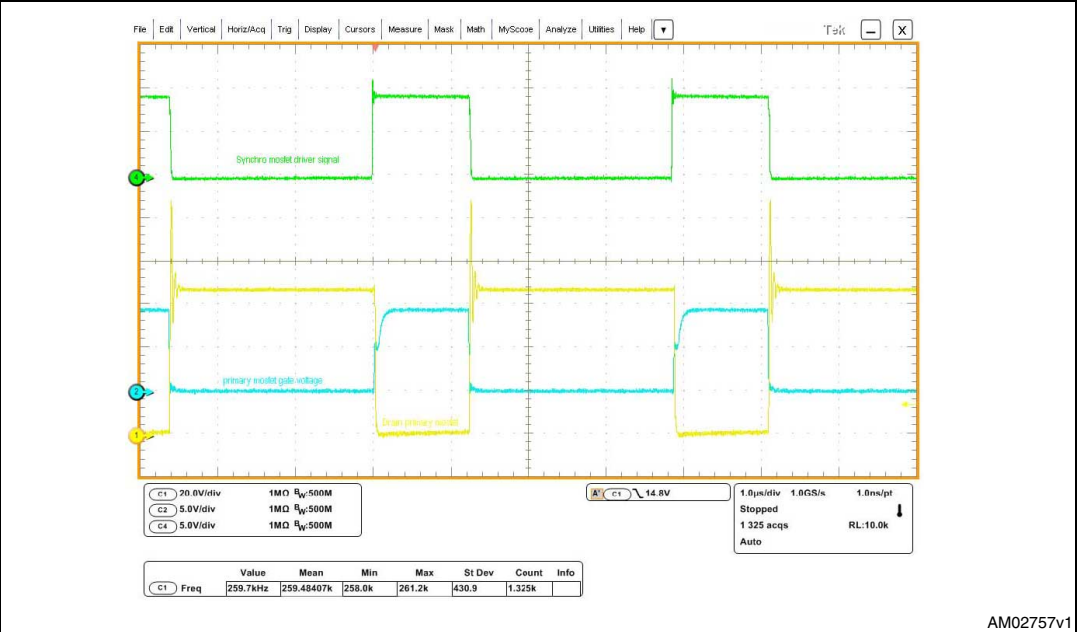


Figure 8. Primary side power MOSFET waveforms at 2 A load



4.2.3 Secondary side MOSFET

Figure 9. Secondary side power MOSFET waveforms at 0 A load

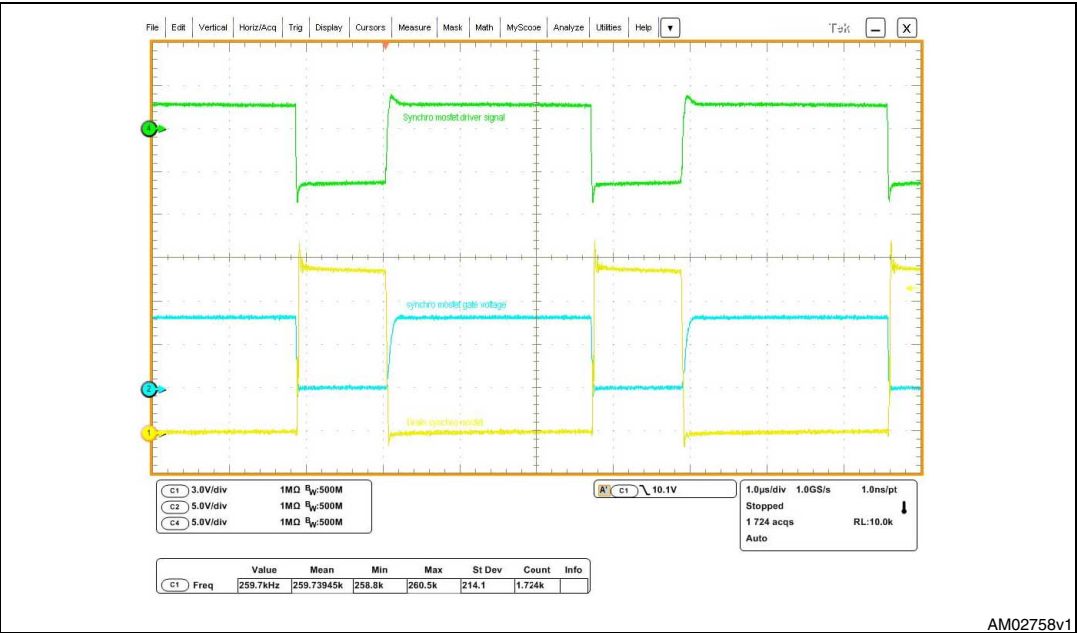


Figure 10. Secondary side power MOSFET waveforms at 2 A load

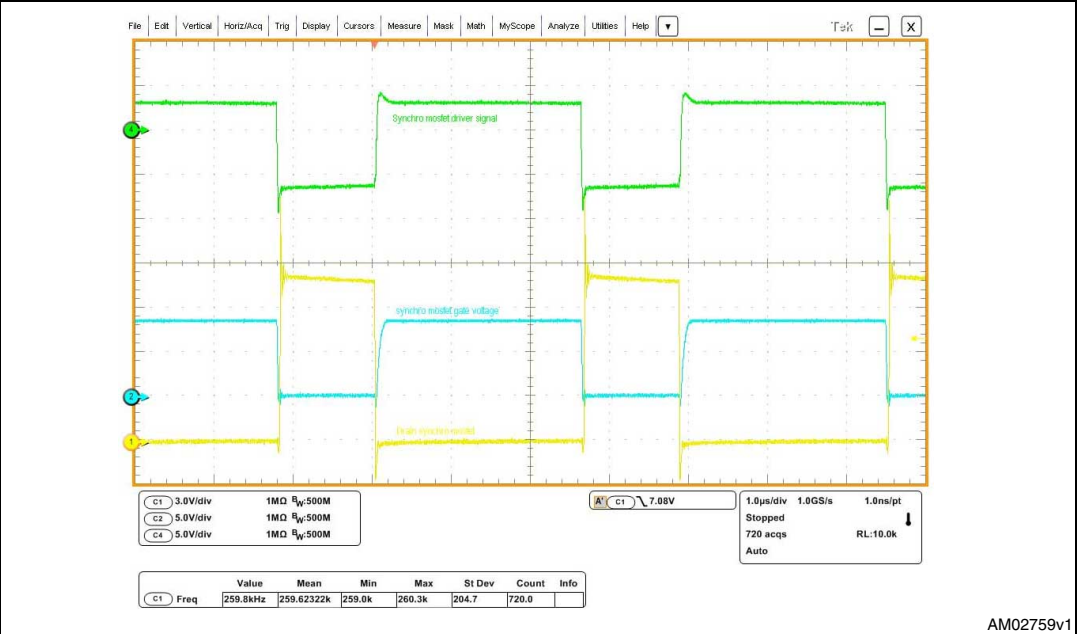
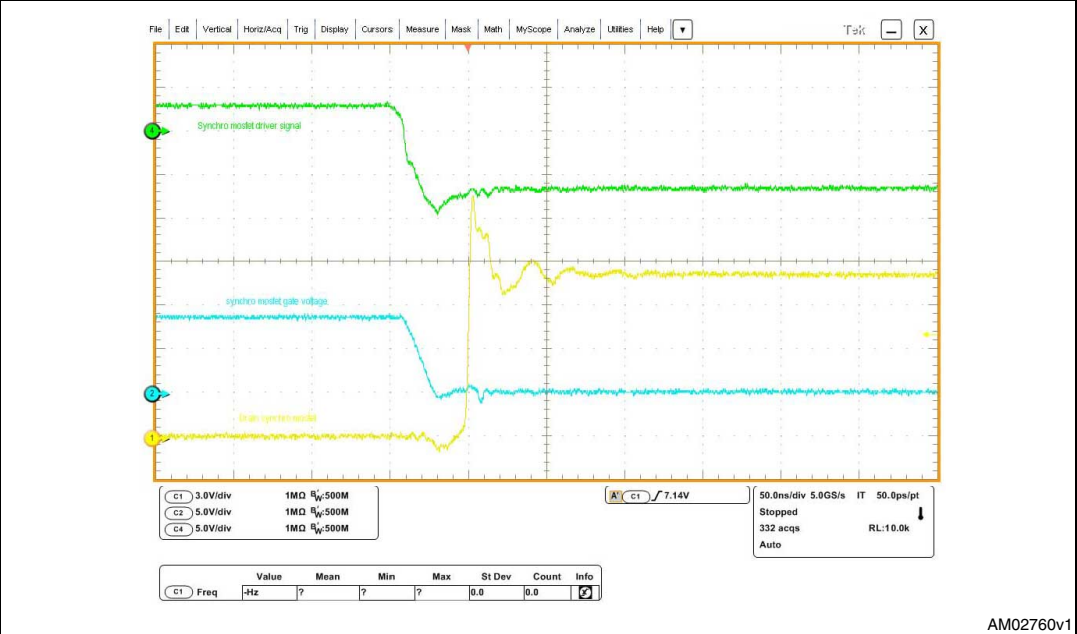
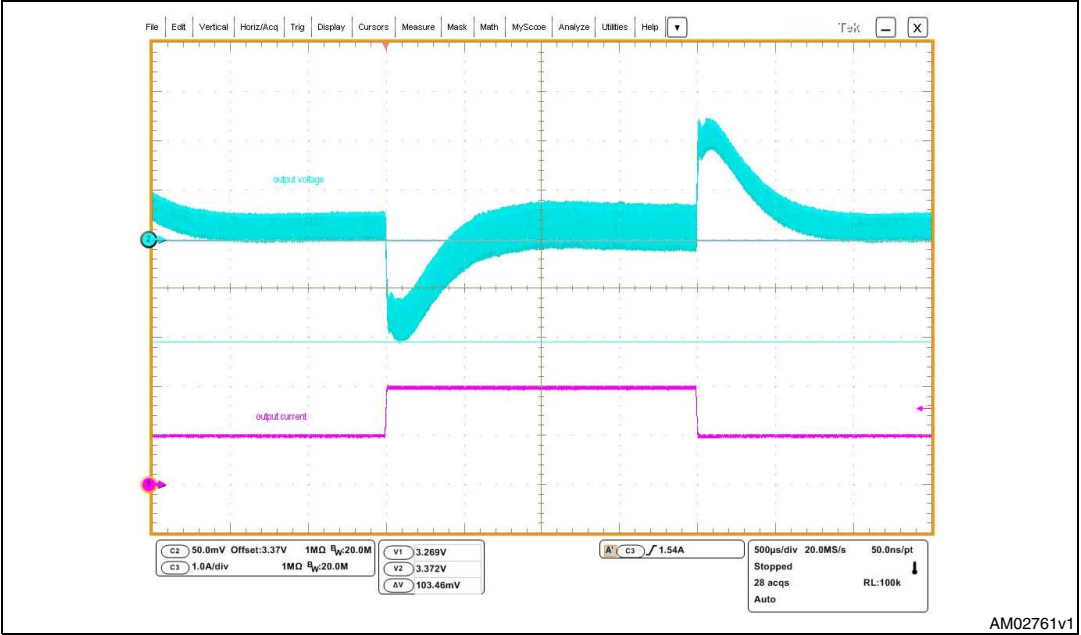


Figure 11. Detail of secondary side power MOSFET waveforms at 2 A load



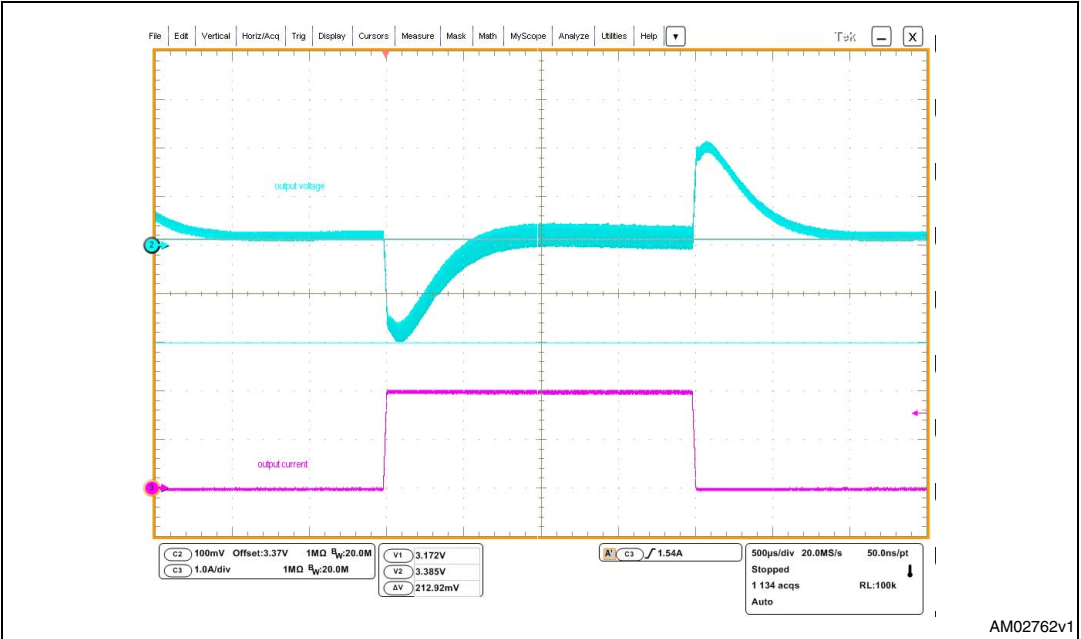
4.2.4 Load transient

Figure 12. Response of the converter to a 1 A - 2 A load transient



AM02761v1

Figure 13. Response of the converter to a 0 A - 2 A load transient



AM02762v1

4.2.5 Output ripple

Figure 14. Output ripple measurement at 2 A

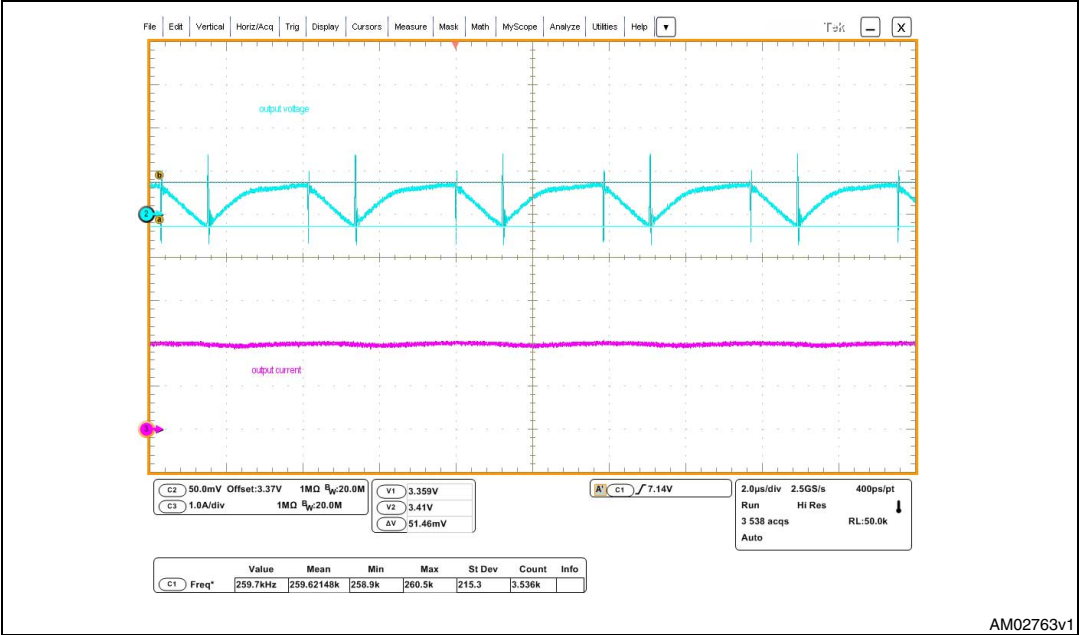
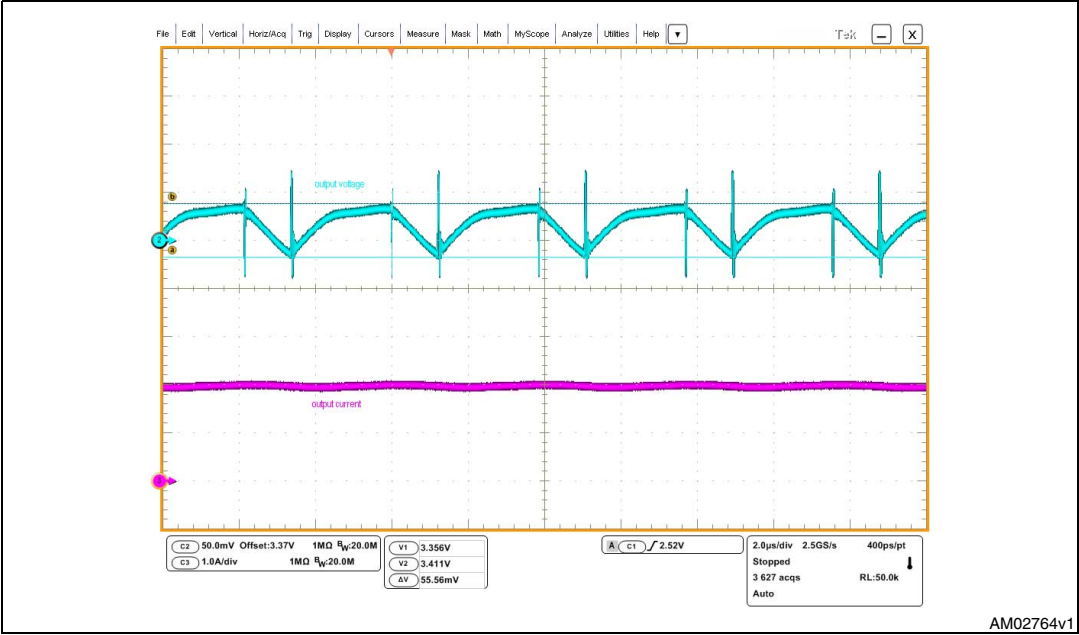


Figure 15. Output ripple measurement at 2 A with infinite persistence



Appendix A Efficiency measurements with diode rectification

Figure 16. Efficiency measurements at 48 V input

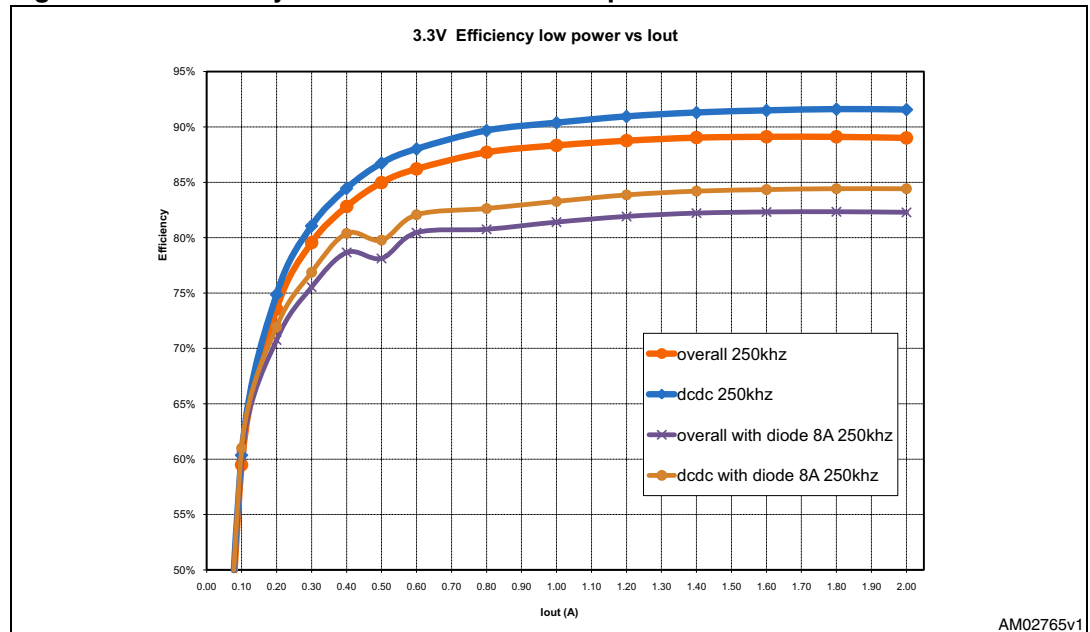
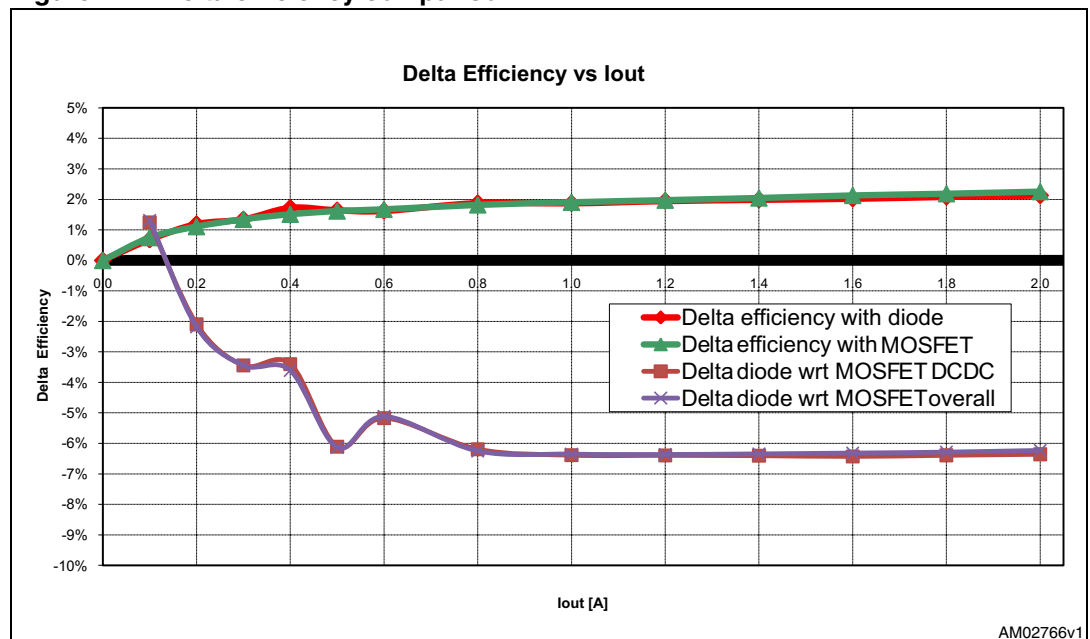


Figure 17. Delta efficiency comparison



The difference between DC-DC and overall measurements is similar in both MOSFET and diode rectification, about 2% from 0.8 A to 2 A.

The difference between MOSFET and diode rectification is similar in both DC-DC and overall measurements, about 6.5% from 0.8 A to 2 A.

Revision history

Table 3. Document revision history

Date	Revision	Changes
06-Apr-2011	1	Initial release

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